Arrhythmia and Atrial Secundum Defect Analysis of Predisposing and Precipitating Factors Responsible for Arrhythmias in Relation to the Age of the Patients

AUTHOR(S):

KONISHI, YUTAKA; TATSUTA, NORIKAZU; MIKI, SHIGEHITO; MATSUDA, MITSUHIKO; ISHIHARA, HIROSHI; TANIGUCHI, TEIICHI; SHIRAISHI, YOSHISADA; ... CHIBA, YUKIO; KAO, CHIN-TZER; HIKASA, YORINORI

CITATION:

KONISHI, YUTAKA ...[et al]. Arrhythmia and Atrial Secundum Defect Analysis of Predisposing and Precipitating Factors Responsible for Arrhythmias in Relation to the Age of the Patients. 日本外科宝函 1978, 47(5): 601-612

ISSUE DATE:

1978-09-01

URL:

http://hdl.handle.net/2433/208293

Arch Jap Chir 47 (5), 601~612, Sept., 1978

臨　　床

Arrhythmia and Atrial Secundum Defect Analysis of Predisposing and Precipitating Factors Responsible for Arrhythmias in Relation to the Age of the Patients

Yutaka Konishi, Norikazu Tatsuta, Shigehito Miki, Mitsuhiko Matsuda, Hiroshi Ishihara, Teiichi Taniguchi, Yoshisada Shiraishi, Nobuyoshi Daito, Kinya Yamada, Shinji Murata, Katsuhiko Murata, Katsuhiko Matsuda, Yukio Chiba, Chin-Tzer Kao and Yorinori Hikasa

The 2nd Department of Surgery, Faculty of Medicine, Kyoto University
(Director : Prof. Dr. Yorinori Hikasa)
Received for Publication may 6, 1978

Summary

A total of 210 patients who underwent a repair of atrial secundum defect were examined concerning the various factors responsible for postoperative arrhythmias. All factors were analyzed in relation to the patients' ages, arranged by decades.

In the first two decades, most patients were asymptomatic with normal pulmonary artery pressures. However, pulmonary artery pressure significantly increased after the third decade and the patients became progressively symptomatic with the development of atrial fibrillation.

The incidence of arrhythmia increased with age, but this was due to the greater frequency of premature beats in the older age groups. Accompanying cardiac malformation, especially mitral or tricuspid valve disease, resulted in an additional tendency toward arrhythmias regardless of age.

None of predisposing factors such as pulmonary artery pressure, magnitude of the left to right shunt and size or location of the defect was correlated with the production of arrhythmia.

With regard to precipitating factors, there was no specific relationship between the type of atriotomy and the occurrence of arrhythmia in any of the age groups. With the use of a patch, children developed more arrhythmias ($p<0.01$), but adults showed arrhythmias more with direct suture closure ($p<0.01$) and with induced ventricular fibrillation ($p<0.01$).

The most popular type of arrhythmia was nodal rhythm with almost the same incidences

Key words : Atrial septal defect, Postoperative arrhythmia, Predisposing factor, Precipitating factor
Present address : The 2nd Department of Surgery, Faculty of Medicine, Kyoto University, Sakyo-ku, Kyoto 606, Japan.

in children (10.7%) and adults (15.1%). However, atrial fibrillation was seen only in the adult patients. In most instances, nodal rhythm developed in the early postoperative days and persisted for few days. On the other hand, atrial fibrillation and sinus bradycardia had a late onset but the duration was short in the former and longest in the latter.

Although the causal relationship between surgical trauma and the development of arrhythmia remained obscure, some possibilities were discussed.

Introduction

An atrial secundum defect is one of the most common congenital heart diseases and its surgical result has become satisfactory in most centers. However, an occasional patient, especially in the older age group, has been complicated by bothersome arrhythmias in the otherwise uneventful postoperative course. Although various aspects such as the patient's age[9)13-17)], pulmonary artery pressure[13)14)16)], size or location of defect[9)], magnitude of the left to right shunt[9)16)], use of patch[5)13)], type of atriotomy[1)] and use of ventricular fibrillation[15)] have been discussed as possible factors for the production of arrhythmia, the only clear cut factors appears to be the age of the patient.

In this report, an attempt was made to analyze the age factor in detail.

Material and Method

A total of 210 patients with the secundum type of atrial septal defect (ASD) were operated on at Kyoto University Hospital from 1962 to1977. One hundred and eighty-four were isolated ASD and 26 were associated with pulmonary stenosis (7cases), partial anomalous pulmonary venous drainage (12 cases), mitral regurgitation (3 cases), tricuspid regurgitation (3 cases), or mitral stenosis combined with tricuspid regurgitation (1 case). In most cases, the operation was performed with the aid of extracorporeal circulation and in only five was deep hypothermia used.

According to age, the patients were divided into two major groups, Group I (Children) and Group II (Adults). Each group was further separated into Group A and Group B, that is, Group I-A : 0 to 9 years, Group I-B : 10 to 19 years, Group II-A : 20 to 29 years, and Group II-B : older than 30 years. In each group, various factors were examined concerning postoperative arrhythmias. Transient arrhythmias that occurred in the operating room and arrhythmias that presented preoperatively were excluded.

Predisposing factors included pulmonary artery pressure, type or location of defect, associated cardiac anomaly and the left to right shunt ratio. Size of the defect was measured at operation assuming that a defect is an ellipse.

Precipitating factors were presumed to be surgical techniques such as the type of atriotomy, use of a patch and use of electrical ventricular fibrillation during atriotomy. The right atriotomy was performed in three different ways, namely, vertical, transverse and oblique incisions. As a patch, a piece of the pericardium was used in most instances.

Result

There were five (2.4%) hospital deaths, 3(1.6%) were isolated ASD, and 2(7.7%) were complicated by partial anomalous pulmonary venous drainage or tricuspid regurgitation.

Preoperative clinical conditions and hemodynamic date are summarized in Table 1 and Figure 1. With advancing age, the patients became symptomatic and especially in the group of patients older than 30 years of age (Group II-B), almost all patients belonged to the New York Heart Association (NYHA) Functional Class II or more. These patients were also revealed to have significant cardiac enlargement. These changes may be chiefly due to the development of atrial fibrillation in this age group.

Group		No. of Case	Age (Mean) (yrs)	NYHA Class I	II	III	CTR	Preoperative Arrhythmia
I	I-A	73	0- 9 (6.1±2.1)	70	3	0	0.55±0.05	
	I-B	58	10- 19 (14.0±3.0)	46	12	0	0.52±0.06	
II	II-A	30	20-29 (23.7±3.0)	15	15	0	0.53±0.06	SB: 1, 2°A-V Block: 1
	II-B	23	30-52 (40.0±6.7)	1	20	2	0.58±0.09	AF: 6, A Flut: 1
	〈AF〉	〈7〉	〈34-52 (44.9±7.2)〉	〈0	5	2〉	〈0.64±0.09〉	

Table 1 Preperative condition in isolated ASD. AF : atrial fibrillation, A Flut : atrial flutter, SB : sinus bradycardia, 〈AF〉 . cases with preoperative atrial fibrillation and atrial flutter.

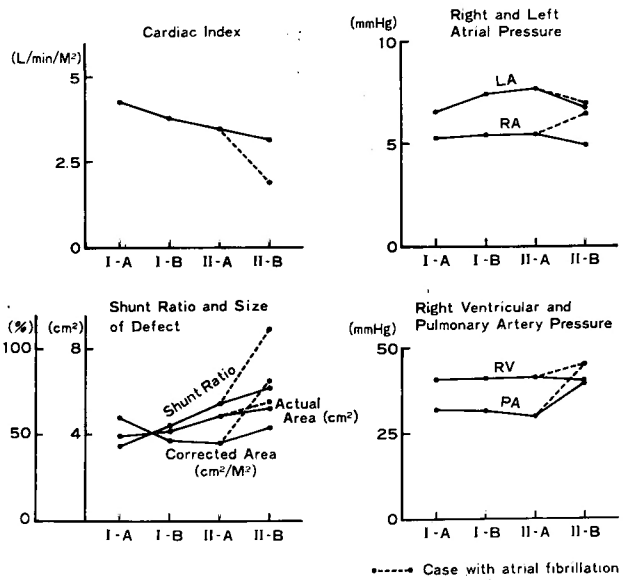

Fig. 1 Preoperative hemodynamic date in relation to age.

Pulmonary artery pressure increased significantly after the third decade ($p<0.001$) but there were no significant changes in the other intracardiac pressures. The left to right shunt ratio and size of the defect became larger with increasing age and a significant step-up of the shunt ratio was found from Group I-B to Group II-A ($p<0.01$). Although the relative area of defect (corrected by body surface area) was largest in the youngest group (Group I-A), there was no correlation between the size of defect and shunt ratio.

Fifty of 184 (27.2%) patients with isolated ASD developed 61 arrhythmias postoperatively (Table 2). This indicated that the patient had 1.22 types of arrhythmia on the

Group	No. of Case	No. of Case with Arrhythmia	AF	NR	SB	SSS	WP	A-V Dis	A-V Block		Other (PAC. PVC & etc)
									1°	2°	
I-A	73	14 (19.2)	0	6 (8.2)	2 (2.7)	0	1 (1.4)	2 (2.7)	1 (1.4)	2 (2.7)	4 (5.5)
I-B	58	15 (25.9)	0	8 (13.8)	2 (3.4)	0	0	0	1 (1.7)	0	5 (8.6)
II-A	30	11 (36.7)	2 (6.7)	6 (20)	1 (3.3)	0	0	0	0	1 (3.3)	3 (10)
II-B	23	10 (43.5)	2 (8.7)	2 (8.7)	1 (4.3)	1 (4.4)	0	0	0	0	8 (34.8)
Total	184	50 (27.7)	4 (2.2)	22 (12.0)	6 (3.3)	1 (0.5)	1 (0.5)	2 (1.1)	2 (1.1)	3 (1.6)	20 (10.9)

Table 2 Postoperative arrhythmia in isolated ASD. ( ) : percent of incidence AF : atrial fibrillation, NRf nodal rhythm, SB : sinus bradycardia, SSS : sick sinus syndrome, WP : wandering pacemaker, A-V Dis : A-V dissociation, PA(V)C : paroxysmal atrial (ventricular) contraction.

average. The incidence of arrhythmia was increased with age and there was a significant difference between Group I and Group II ($p<0.02$). The most frequent type of arrhythmia was nodal rhythm (12%) with almost the same incidence in Group I (10.7%) and Group II (15.1%), while atrial fibrillation was found in only 4 cases of the adult groups.

In cases of associated ASD, arrhythmias became more frequent regardless of the patient's age and one patient had an average of 2.33 types of arrhythmia (Table 3). Especially in the cases with associated mitral or tricuspid disease, all the patients showed postoperative arrhythmia, while pulmonary stenosis and partial anomalous pulmonary venous drainage did not show any additional tendency toward arrhythmias (Table 4). Moreover, there was no relationship between the type of arrhythmia and the type of associated anomaly except that all three cases of mitral regurgitation were complicated by first degree A-V blocks postoperatively.

Omitting transient or indefinite arrhythmias such as atrial or ventricular premature contraction or unknown types of tachycardia or bradycardia because of no electrocardiographic strip, preoperative conditions and surgical techniques were examined as possible factors for the production of a postoperative arrhythmia (Table 5 and 6).

Group	No. of Case	No. of Case with Arrhyth-mia	AF	NR	SB	SSS	WP	A-V Dis	A-V Block		Other (PAC. PVC & etc)
									1°	2°	
I-A	11	5 (45.5)	0	3 (25)	0	0	1 (9.1)	2 (18.2)	2 (18.2)	1 (9.1)	4 (33.3)
I-B	7	3 (42.9)	0	0	0	0	0	1 (14.3)	1 (14.3)	0	2 (28.6)
II-A	4	0	0	0	0	0	0	0	0	0	0
II-B	4	4 (100)	1 (25)	3 (75)	2 (50)	2 (50)	0	1 (25)	1 (25)	0	1 (25)
Total	26	12 (46.2)	1 (8.8)	6 (23.1)	2 (7.7)	2 (7.7)	1 (3.8)	4 (15.4)	4 (15.4)	1 (3.8)	7 (26.9)

Table 3 Postoperative arrhythmia in complicated ASD. ( ) : percent of incidence, AF: Atrial fibrillation, NR: nodal rhythm, SB: sinus bradycardia, SSS: sick sinus syndrome, WP : wandering pacemaker, A-V Dis : A-V dissociation, PA(V)C: paroxysmal atrial (ventricular) contraction.

Group	No. of Case	No. of Case with Arrhyth-mia	AF	NR	SB	SSS	WP	A-V Dis	A-V Block		Others (PAC. PVC & etc)
									1°	2°	
ASD+TR	3	3 (100)	0	2 (66.7)	1 (33.3)	1 (33.3)	0	2 (66.7)	0	0	1 (33.3)
ASD+MR	3	3 (100)	1 (33.3)	1 (33.3)	1 (33.3)	1 (33.3)	0	1 (33.3)	3 (100)	0	1 (33.3)
ASD+MS+TR	1	1 (100)	0	0	0	0	0	0	0	0	1 (100)
ASD+PS	7	2 (28.6)	0	1 (14.3)	0	0	0	0	0	0	2 (28.6)
ASD+PAPVD	12	4 (33.3)	0	2 (16.7)	0	0	1 (8.3)	1 (8.3)	1 (8.3)	1 (8.3)	2 (16.7)

Table 4 Postoperative arrhythmia in complicated ASD. ( ) : percent of incidence, AF: atrial fibrillation, NR: nodal rhythm, SB: sinus bradycardia, SSS: sick sinus syndrome, WP: wandering pacemaker, A-V Dis: A-V dissociation, PA(V)C : paroxysmal atrial (ventricular) contraction, TR : tricuspid regurgitation, MR : mitral regurgitation, MS : mitral stenosis, PS : pulmonary stenosis, PAPVD : partial anomalous pulmonary venous drainage.

Group	No. of Case	No. of Case with Arrhyth-mia	Pulmonary Artery Pressure (mmHg)			Shunt Ratio (%)			Area of Defect (cm^2/M^2)			Location of Defect		
			-29	30-49	50-	-39	40-59	60-	-1.9	2.0-4.9	5.0-	Sinus Venosus	Central	Inferior
I-A	73	12 (16.4)	7/29 (24.1)	5/35 (21.7)	0/3 (0)	5/18 (27.3)	4/33 (12.1)	3/20 (15.0)	1/9 (11.1)	8/45 (17.8)	2/25 (8.0)	0/1 (0)	10/60 (16.7)	2/13 (15.4)
I-B	58	12 (20.8)	2/24 (8.3)	5/22 (22.7)	1/3 (33.3)	4/13 (30.8)	3/22 (13.6)	4/18 (22.2)	6/19 (31.6)	4/27 (14.8)	2/10 (20)	0/1 (0)	11/48 (22.9)	0/8 (0)
II-A	30	8 (26.8)	3/14 (21.4)	4/12 (33.3)	0/1 (0)	1/3 (33.3)	2/9 (22.2)	5/16 (31.2)	2/4 (50)	5/19 (26.3)	1/7 (14.3)	0/1 (0)	7/26 (26.9)	1/3 (33.3)
II-B	23	4 (17.4)	1/6 (16.7)	3/14 (21.4)	0/3 (0)	0	3/7 (42.9)	1/16 (6.3)	0/3 (0)	3/13 (23.1)	1/7 (14.3)	0	3/20 (15)	1/3 (33.3)
Total	184	36 (19.6)	13/73 (17.8)	17/83 (20.5)	1/10 (10)	10/34 (29.4)	12/71 (16.9)	13/70 (18.6)	9/35 (25.7)	20/104 (19.2)	5/49 (10.2)	0/3 (0)	31/154 (20.1)	4/27 (14.8)

Table 5 Postoperative arrhythmia related to preoperative condition in isolated ASD. ( ) : percent of incidence, Premature (atrial or ve ntricular) beats were excluded in this table.

Group	No. of Case	No. of Case with Arrhythmia	Type of Atriotomy			Closure of Defect		Procedure	
			Vertical	Transverse	Oblique	Patch	Direct	Beating	Fibrillation
I-A	73	12 (16.4)	1/11 (9.1)	7/36 (19.4)	3/20 (15)	1/3 (33.3)	10/70 (14.3)	8/52 (15.4)	2/16 (12.5)
I-B	58	12 (20.7)	3/15 (20)	7/21 (33.3)	1/16 (6.3)	2/3 (66.7)	9/54 (16.7)	10/42 (23.8)	1/15 (6.7)
II-A	30	8 (26.7)	3/7 (42.9)	3/16 (18.8)	2/4 (50)	0/4 (0)	8/26 (30.8)	7/26 (26.9)	1/3 (33.3)
II-B	23	4 (17.4)	0/2 (0)	1/12 (8.3)	3/9 (33.3)	0/5 (0)	4/18 (22.2)	0/14 (0)	4/9 (44.4)
Total	184	36 (19.6)	7/35 (20)	18/85 (21.2)	9/49 (18.4)	3/15 (20)	31/168 (18.5)	25/134 (18.7)	8/43 (18.6)

Table 6 Postoperative arrhythmia related to surgical technique in isolated ASD. ( ) : percent of incidence, Premature (atrial or ventricular) beats were excluded in this table.

Neither pulmonary artery pressure, shunt ratio, nor size of the defect appeared to be related to frequency of postoperative arrhythmias in any of the age groups.

With regard to location of the defect, there were no appreciable differences in the incidence between central (fossa ovalis defect) (20.1%) and inferior (inferior caval defect) (14.8%) types. However, the sinus venosus type did not produce any arrhythmias and this was true even in the cases complicated by partial anomalous pulmonary venous drainage.

Although the total incidence of arrhythmia was not influenced by the surgical techniques, some procedures showed different effects on the production of arrhythmias in different age groups. The closure of defects with patchs had a higher incidence of arrhythmia than the direct suture closure in Group I ($p<0.05$), but vice versa in Group II ($p<0.001$). In the use of electrical ventricular fibrillation, postoperative arrhythmias significantly increased in Group II ($p<0.01$), while in the younger groups there were no significant differences.

As for the relationship between surgical techniques and the type of arrhythmia, no specific correlation was found in most instances (Table 7). However, in Group I nodal rhythm appeared to occur more frequently in patch-repaired cases. On the other hand, in Group II atrial fibrillation as well as nodal rhythm developed exclusively in suture-repaired cases.

The time of onset and duration of the three most frequent arrhythmias were shown in Table 8. Nodal rhythm appeared on the early postoperative days, whereas atrial fibrillation and sinus bradycardia occurred about one week after the operation. Although the duration of nodal rhythm and atrial fibrillation was within the period of 2 to 3 days, sinus bradycardia persisted more than 2 weeks.

The cases with arrhythmias persistent until discharge were followed up (Table 9). Of cases of preoperative atrial fibrillation, two were reverted to sinus rhythm but atrial fibrillation lasted in another seven. The remaining one, a 51 old female with associated tricuspid regurgitation, was converted to sinus rhythm immediately after the operation but

	Group	Type of Factor	No. of Case	No. of Case with Arrhythmia	AF	NR	SB	SSS	WP	A-V Dis	A-V Block	
											1°	2°
Atriotomy	I	Vertical	25	4 (16)	0	2 (8)	1 (4)	0	0	0	1 (4)	0
		Transverse	57	14 (24.6)	0	9 (15.8)	2 (3.5)	0	1 (1.8)	1 (1.8)	0	1 (1.8)
		Oblique	36	5 (13.9)	0	3 (8.3)	1 (2.8)	0	0	1 (2.8)	2 (5.6)	1 (2.8)
	II	Vertical	9	3 (33.3)	1 (11.1)	3 (33.3)	0	0	0	0	0	0
		Transverse	28	4 (14.3)	2 (7.1)	3 (10.7)	0	0	0	0	0	0
		Oblique	13	5 (38.5)	1 (7.7)	2 (15.4)	2 (15.4)	1 (7.7)	0	0	0	0
Use of Patch	I	Patch	6	3 (50)	0	3 (50)	1 (16.7)	0	0	0	1 (16.7)	0
		Direct	124	19 (15.3)	0	11 (8.9)	3 (2.4)	0	1 (0.8)	2 (1.6)	2 (1.6)	2 (1.6)
	II	Patch	9	0	0	0	0	0	0	0	0	0
		Direct	44	12 (27.3)	4 (9.1)	8 (18.2)	2 (4.5)	1 (2.3)	0	0	0	1 (2.3)
Use of Fibrillation	I	Beating	94	18 (19.1)	0	12 (12.8)	3 (3.2)	0	1 (1.1)	1 (1.1)	0	1 (1.1)
		Fibrillation	31	4 (12.9)	0	2 (6.5)	1 (3.2)	0	0	1 (3.2)	2 (6.5)	1 (3.2)
	II	Beating	41	7 (17.1)	2 (4.9)	6 (14.6)	0	0	0	0	0	1 (2.4)
		Fibrillation	12	5 (41.7)	2 (16.7)	2 (16.7)	2 (16.7)	1 (8.3)	0	0	0	0
Location of Defect	I	Sinus Venosus	2	0	0	0	0	0	0	0	0	0
		Central	106	20 (18.9)	0	13 (12.3)	3 (2.8)	0	1 (0.9)	1 (0.9)	2 (1.9)	2 (1.9)
		Inferior	21	2 (9.5)	0	1 (4.8)	1 (4.8)	0	0	1 (4.8)	1 (4.8)	0
	II	Sinus Venosus	1	0	0	0	0	0	0	0	0	0
		Central	46	10 (21.7)	3 (6.5)	8 (17.4)	1 (2.2)	1 (2.2)	0	0	0	1 (2.2)
		Inferior	6	2 (33.3)	1 (16.7)	0	1 (16.7)	0	0	0	0	0

Table 7 Relationship between surgical technique and type of postoperative arrhythmia. ( ) : percent of incidence, AF atrial fibrillation, NR: nodal rhythm, SB: sinus bradycardia, SSS: sick sinus syndrome, WP: wandering pacemaker, A-V Dis: A-V dissociation, Premature (atrial or ventricular) beats were excluded in this table.

Type of Arrhythmia	No. of Case	Age (Average)	Onset (days after surgery)	Duration (days)
AF	4	28-47 (35.5±10.7)	9.0±6.5	3.2±4.9
NR	26	4-37 (16.8±11.0)	1.4±2.0	2.3±3.4
SB	6	4-34 (16.7±11.6)	6.2±5.6	19.8±22.8*

Table 8 Onset and duration of postoperative arrhythmia. AF: atrial fibrillation, NR : nodal rhythm, SB : sinus bradycardia, *A case which had sinus bradycardia at the time of study was excluded.

died from an Adam-Stokes attack due to sick sinus syndrome. Preoperative sinus bradycardia and second degree A-V block were not changed by surgery. Nine cases of preoperative sinus rhythm were discharged with various types of postoperative arrhythmias. All but one were reverted to normal sinus rhythm within one year, whereas one case remained in sinus bradycardia one year later.

The postoperative condition of adult patients were followed on an average of 6 years after surgery (Table 10). All patients of Group II-A belonged to Functional Class I, while

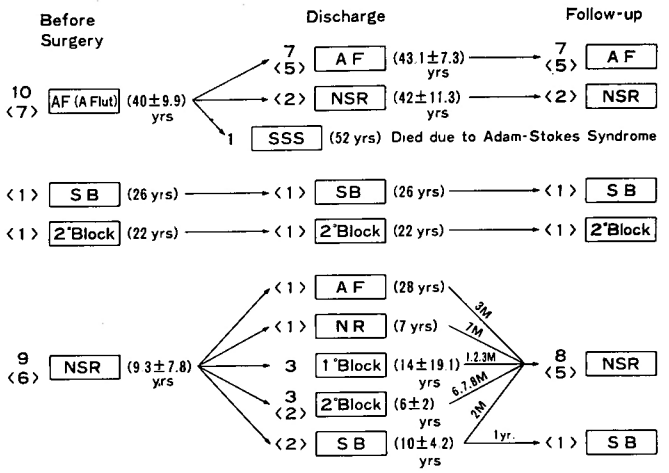

Table 9 Follow-up of long-term arrhythmia. 〈 〉: isolated ASD, AF: atrial fibrillation, A Flut: atrial flutter, SB: sinus bradycardia, NR: nodal rhythm, SSS: sick sinus syndrome, NSR: normal sinus rhythm.

Group	NYHA	Pre-operative	Post-operative	Transient Arrhythmia at present
II-A	I	〈15〉	24 〈23〉	〈2〉
	II	19 〈15〉	0	0
II-B	I	〈1〉	16 〈14〉	〈3〉
	II	22 〈20〉	6 〈5〉	〈4〉
	III	4 〈2〉	〈1〉	0

Table 10 NYHA Class before and after surgery. 〈 〉: isolated ASD, A total of 13 patients could not be followed because of various reasons, 10 in Group II-A and 3 in Group II-B. Follow-up period was 6 years on the average.

22 percent of Group II-B remained in Functional Class II or more. In addition, about 30 percent of Group II even in patients of Functional Class I, have been bothered by occasional arrhythmias which were not recorded because of their transient occurrences.

Discussion

Hemodynamic Changes of ASD with Age···The analysis of the patients with ASD arranged by decades can make a presumption of the natural history of this disease. In the first two decades, most of the patients were asymptomatic with normal pulmonary artery pressures. With advancing age pulmonary artery pressure significantly increased and the patients became symptomatic with the development of atrial fibrillation or tricuspid regurgitation. This course appears to be simillar to the natural history of this disease reported by Craig et al.[6] and Campbell et al.[4], although cyanosis due to reversal of the shunt following raised pulmonary artery pressure was not demonstrated in this study.

Incidence of Arrhythmia in Relation to Age···The trend of a greater incidence of arrhythmia with age has been demonstrated by many authors[9)13-17)]. A similar result was obtained in our study. However, if we excluded premature beats, the incidence of arrhythmia was not significantly high in the older age groups. This higher incidence of ectopic beats in adults might be related to not only the disease but also the ageing change itself[2)]. Associated anomalies increased the frequency of arrhythmia regardless of the patient's age.

Predisposing Factors··· Pulmonary artery pressure[14)], magnitude of the left to right shunt ratio[9)16)] and size of the defect[9)] have been pointed out as possible factors influencing postoperative arrhythmias. However, in our study these factors showed no specific relation to arrhythmias in any of the age groups. Fuse et al.[9)] demonstrated the high incidence of arrhythmias in cases with a sinus venosus defect. It is possible for the internodal tracts or the sinoatrial (SA) node to be easily damaged at the time of closure of a high septal defect although our six cases of this type with or without associated anomalies did not produce any arrhythmias.

Precipitating Factors···Although the etiologies of arrhythmia have not been clearly understood, surgical trauma to the conduction system probably contributed to the production of postoperative arrhythmias. The atrial conduction system including the SA node, the internodal tracts and the atrioventricular (AV) node, are very susceptible to injury during surgery for ASD, not only from the direct surgical trauma such as cutting or suturing but also from secondary edema or hemorrhage (Fig. 2).

Regarding location of the atrial incision (Fig. 3), a transverse atriotomy appears to be easiest for division of the crista terminalis where the posterior internodal tract is located. A vertical atriotomy anterior to the crista terminalis can endanger the SA node while extending the incision upward although this incision may preserve the posterior tract[10)]. Theoretically, an oblique incision can preserve

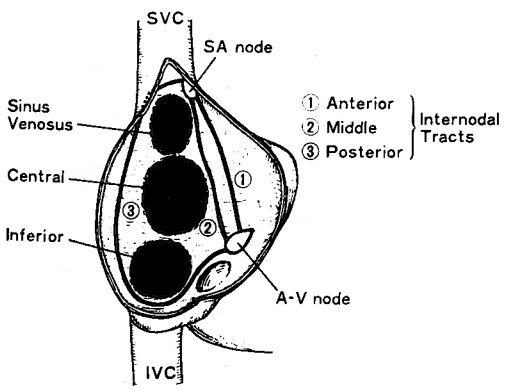

Fig. 2 Location of defect and conduction system in the atrium.

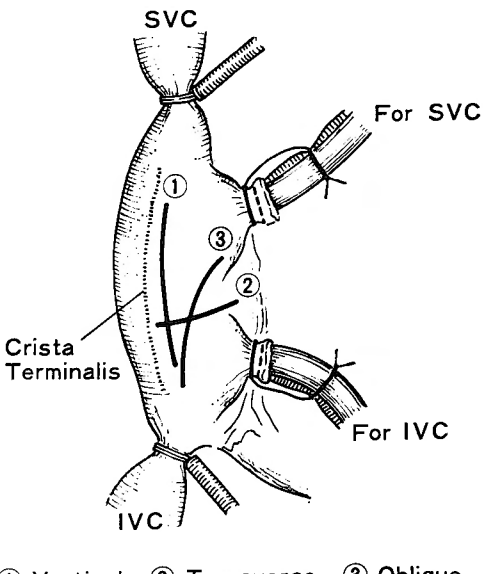

Fig. 3 Types of atriotomy.

both the SA node and the posterior tract and one can enlarge the incision safely in either direction. However, in this study, there was no statistically significant difference in the incidence of postoperative arrhythmia among these different atriotomies. Additional injury to the SA node can be made by the cannula itself in the superior vena cava or by the anchoring suture for the cannula or by a tourniquet around the superior vena cava[11]. The AV node appears to have the least chance of the damage by direct surgical procedures. However, the traction by a retractor or coronary suction apparatus may produce edema or hemorrhage in this area The anterior and middle internodal tracts could likely be damaged by sutures placed around the edge of the defect in closing it. In addition, the transseptal approach for the mitral valve repair could very easily injury these tracts by a retractor. Bowman et al.[3] noted frequent A-V dissociation following this approach. On the other hand, Holsinger et al.[10] found in their dog experiment that the division of the anterior internodal tract provoked a delay of A-V conduction. All of our cases associated with mitral regurgitation, in which the mitral valve repair was performed utilizing transseptal approach, developed first degree A-V blocks postoperatively.

Chen et al.[5] and Popper et al.[13] demonstrated no significant difference in the incidence of arrhythmia between suture-repaired and patch-repaired cases, while Fuse et al.[9] noted a higher incidence in the cases with patch closure. In our series, the over-all incidence of arrhythmia was not influenced by the use of a patch. However, in children, patch-repaired cases more frequently developed arrhythmias, whereas in adults suture-repaired cases did. The direct suture closing could yield too much stretching or tension or even tear into the atrial septum in some instances. It is likely that the adult septum could be more vulnerable to this kind of injury even in cases with small defects and produce edema or hemorrhage very easily in the area of the internodal tracts, although that of a child appears to be elastic and to be able to tolerate such stretching relatively well. It is not ascertained why patch closing in children resulted in the higher incidence of arrhythmias.

The use of artificial ventricular fibrillation was pointed out by Saigusa et al.[15] as a possible factor for the production of arrhythmia. Yang et al.[18] reported that the SA node might fail to resume the normal pacemaker activity after electrical depolarization of the heart and might result in the dominance of the lower pacemaker. In our study, the significant influence of induced ventricular fibrillation was seen in adults, especially in the older group, but not in children. This indicates that the SA node become more susceptible to electrical stimulus with increasing age.

Type, Onset and Duration of Arrhythmias…In most instances, there was no relationship between the type of arrhythmia and surgical technique. However, in childen, nodal rhythm was seen more frequently in patch-repaired cases than in direct suture cases but vice versa in adults. The reason of this difference remains obscure at present.

As for the onset and duration of postoperative arrhythmias, nodal rhythm developed in the early postoperative days both in children and adults and persisted only for a few days. On the other hand, both atrial fibrillation and sinus bradycardia had a late onset, but the

duration was short in the former and longest in the latter.

Of 36 patients with these arrhythmias, four patients who were all children developed arrhythmia immediately after the operation. Three with nodal rhythm resumed sinus rhythm but the remaining one still maintained sinus bradycardia one year later. These arrhythmias in the immediate postoperative period were considered to be caused by direct surgical trauma and this seem to be really possible when the small children's hearts were treated by the relatively large surgical intervention with some technical difficulties. On the other hand, most of arrhythmias which had a later onset might have been due to edema or inflammation secondary to surgical manipulations. Many of the lesions were temporary and resolved with the disappearance of arrhythmias. However, the actual trauma such as cutting or suturing might have caused permanent arrhythmias. The retardation of the functional recovery of the SA node was revealed by the longer duration of sinus bradycardia.

Postoperative Condition···The satisfactory result of repair of ASD was reported even in aged patients[7)8)12)]. A follow-up study on our adult patients revealed that the improvement of Functional Class was found in 24 of 37 patients (64.9%) who belonged to Functional Class II or more preoperatively. It should be noted, however, that some patients have been bothered by occasional arrhythmia which might be related to senile change as well as the disease.

Reference

1) Bekier J: Die Auswirkung der Vorhofinzision auf die Häufigkeit der postoperativen Herzrhythmusstörungen beim Verschluß des Vorfhofseptumdefektes. Thoraxchirurgie **18** : 154–164, 1970.
2) Bellet S: Clinical disordes of the heart beat. 3rd ed. Lea & Febiger Co. p251–309, 1971.
3) Bowman RO et al: The transseptal approach to mitral valve repair. Arch Surg **90** : 329–331, 1965.
4) Cambell M: Natural history of artial septal defect. Brit Heart J **32** 820–826, 1970.
5) Chen S et al: Postoperativo conduction disturbances in atrial septal defect. Am J Card **22** 636–644, 1968.
6) Craig RJ et al: Natural history and prognosis of atrial septal defect. Circulation **37** : 805–815, 1968.
7) Dave KS et al: Atrial septal defect in adults. Clinical and hemodynamic results of surgery. Am J Card **31** 7–13, 1973.
8) Forfang K et al: Atria septal defect of secundum type in the middle-aged. Clinical results of surgery and correlations between symptoms and hemodynamics. Am Heart J **94** 44–54, 1977.
9) Fuse K et al: Postoperative arrhythmia in atrial septal defect. Heart 7: 1278–1284, 1975. (Japanese with English abstract)
10) Holsinger JW et al: The identification and surgical significance of the atrial internodal conduction tracts. Ann Surg **167** : 447–453, 196y.
11) Kenneth SK et al: Injury of the sinus node in open-heart operations. J Thoracic & Cardiovas Surg **53** 814–829, 1967.
12) Nasrallah AT et al: Surgical repair of atrial septal defect in patients over 60 years of age. Long-term results. Circulation **53** : 329–331, 1976.
13) Popper RW et al: Arrhythmia after cardiac surgery. I. Uncomplicated atrial septal defect. Am Heart J **64** 455–461, 1962.
14) Reid JM et al: Cardiac arrhythmia following successful surgical closure of atrial septal defect. Brit Heart J **29** 742–746, 1967.
15) Saigusa M et al: Postoperative arrhythmia of atrial septal defect. Jap J Thoracic Surg **20** : 748–752. 1967. (Japanese with English abstract)
16) Sealy WC et al: Atrial dysrhythmia and atrial secundum defects. J Thoracic Cardiovas Surg **57** 245–250, 1969.

17) Shirabe J et al: Clinical study of postoperative arrhythmia in atrial septal defect. Jap J Thoracic Surg **30** 503-507, 1977. (Japanese with English abstract)
18) Yang SS et al: Cardioversion following open-heart valvular surgery. Brit Heart J **28**: 309-315, 1966.

和文抄録

不整脈と心房中隔欠損症 年令別にみた不整脈発生の素因と誘因についての分析

京都大学医学部外科学教室第2講座

小西 裕，龍田憲和，三木成仁，松田光彦，
石原 浩，谷口亨一，白石義定，大頭信義，
山田公弥，村田真司，村田雄彦，松田捷彦，
千葉幸夫，高 欽 沢，日笠頼則

心房中隔欠損症の手術は現在多くの施設で最も頻回に行なわれているものの一つで，その成績もきわめて満足すべきものとなっている．しかし比較的多数の症例に術後に不整脈が出現することは，その他の術後経過が順調なだけに，従来より重要な課題として論議されてきた．過去に指摘された術後不整脈発生の素因或いは誘因と考えられるものは，年令，肺動脈圧，欠損孔の位置および大きさ，短絡率，合併心奇形，心房切開法，パッチ使用および人為細動の使用などであり，その作用は報告者により必ずしも一致しない．しかし年令因子は最も多くの人が指摘するところであり，我々は本論文において患者年令が如何なる点において不整脈発生に関与しているかを詳細に検討せんと試みた．

対象は昭和37年以後昭和52年末まで，我々の施設で根治術が行なわれた二次孔心房中隔欠損症210例で，それを0—9才，10—19才，20—29才および30才以上の四グループに分け，上記諸因子を各々のグループについて検討した．その結果は以下の如くである．

1) 症例の年令別分類により，本疾患の自然歴が推察された．すなわち30才頃までは大部分の症例は無症状に経過し，肺動脈圧も正常であるが，30才以后肺動脈圧の上昇，心房細動の発生を併ない症状の出現がある．

2) 術后不整脈発生率は加令と共に高くなるが，これは主として心房性あるいは心室性期外収縮の増加によると考えられた．

3) 合併心奇形は年令に関係なく不整脈を増加させ，とくに僧帽弁および三尖弁疾患の合併例では高率に術后不整脈がみられた．

4) 肺動脈圧，短絡率および欠損孔の位置および大きさは，どの年令層においても不整脈発生との特別な関連はみられなかった．

5) 心房切開法，パッチ使用の有無および人為細動使用の有無は全体としては不整脈発生との関係はみられなかった．しかし年令別にみると，パッチ使用は20才以下の若年者において影響が認められ，一方20才以上の成人においては直接縫合および人為細動が有意に術后不整脈の発生に関与した．

6) 術后不整脈は結節調律が最も多く，発生率は若年者と成人では有意差はなかった．又その発生は術后早期に多く，そして大部分数日で消失した．心房細動は成人にのみ見られ，比較的遅発であるが，持続は短かい．洞性徐脈は遅発かつ持続も遷延する傾向があった．

従来一律に論じられていた不整脈発生の素因および誘因が若年者と成人ではその影響は必ずしも同程度ではなく，若年層に強く影響するもの，高年層に影響があるものなどがある．しかし不整脈の病因についてはまだまだ不明な点が多く，今后の課題と考えられる．